MycoKeys 118: 289–311 (2025)
DOI: 10.3897/mycokeys.118.155560

Research Article

Four new species of *Collybiopsis* (Omphalotaceae, Agaricales) from subtropical regions of China

Ling Ding[1], Ben-Jian Zhong[1], Hui Zeng[2], Sheng-Nan Wang[1,3], Jun-Qing Yan[1]

1 *Jiangxi Provincial Key Laboratory of Excavation and Utilization of Agricultural Microorganisms, Jiangxi Agricultural University, Nanchang 330045, China*
2 *Institute of Edible mushroom, Fujian Academy of Agricultural Sciences, Fuzhou 350011, China*
3 *Jiangxi Provincial Key Laboratory of Subtropical Forest Resource Cultivation, College of Forestry, Jiangxi Agricultural University, Nanchang 330045, China*
Corresponding authors: Sheng-Nan Wang (wangshengnan_2003@163.com); Jun-Qing Yan (yanjunqing1990@jxau.edu.cn)

Abstract

Four new species of *Collybiopsis*, namely *C. subpolygramma*, *C. fucata*, *C. dentata*, and *C. latispora*, were discovered in the subtropical regions of China. These species were identified based on morphological characteristics and molecular analysis. Morphologically, *C. subpolygramma* is characterized by its pileal surface, white in color with a light brown center; slender, cylindrical cheilocystidia; and absence of pleurocystidia. *C. fucata* is recognized by the reddish-brown, hygrophanous pileus; adnate to adnexed lamellae; and relatively broad basidiospores. *C. dentata* is identified by free lamellae, fusiform to utriform pleurocystidia, and relatively broad basidiospores. *C. latispora* is distinct by relatively broad basidiospores and a minute, snow-white ring or ruff at the stipe base. In the phylogenetic analysis based on combined ITS and LSU sequences, the four new species formed distinct and stable branches (BI-PP = 1; ML-BP = 100%), respectively. *Collybiopsis subpolygramma* formed a sister lineage with *C. polygramma*. The new species *C. fucata*, *C. dentata*, and *C. latispora* were found to be nested within the *C. ramealis* species complex clade. Detailed descriptions, color photos, and a key to related species are presented.

Key words: Basidiomycetes, new taxa, phylogeny, taxonomy

OPEN ACCESS

Academic editor: Heng Zhao
Received: 11 April 2025
Accepted: 19 May 2025
Published: 11 June 2025

Citation: Ding L, Zhong B-J, Zeng H, Wang S-N, Yan J-Q (2025) Four new species of *Collybiopsis* (Omphalotaceae, Agaricales) from subtropical regions of China. MycoKeys 118: 289–311. https://doi.org/10.3897/mycokeys.118.155560

Copyright: © Ling Ding et al.
This is an open access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International – CC BY 4.0).

Introduction

Collybiopsis (J. Schröt.) Earle was established by Earle in 1909, with *C. ramealis* (Bull.) Millsp. designated as the type species (Petersen and Hughes 2021; Kim et al. 2022). This genus includes 91 records in Index Fungorum [https://indexfungorum.org (accessed on 12 May 2025)], comprising approximately 84 species. The species of *Collybiopsis* are characterized by collybioid, gymnopoid, marasmielloid, omphalioid, and pleurotoid basidiomata; free to decurrent lamellae; a central to eccentric, insititious to subinsititious stipe; ellipsoid to oblong, inamyloid, and hyaline basidiospores with white spore prints; presence of caulocystidia; and coralloid or diverticulate terminal elements of pileipellis (Oliveira et al. 2019; Kim et al. 2022; Razzaq et al. 2023). Species of *Collybiopsis* are mainly distributed in tropical and temperate climates, with most species being saprobic on dead wood of angiosperms and gymnosperms, as well as leaf litter (Petersen

and Hughes 2021; Kim et al. 2022; Razzaq et al. 2023). Some species of *Collybiopsis*, as members of wood-decaying fungi, play a crucial role in maintaining the balance of forest ecosystems and in degradation and reduction processes. For instance, they secrete various bio-enzymes, such as extracellular enzymes, to degrade the cellulose, lignin, and hemicellulose in wood, thereby promoting the material cycle in the ecosystem (Wei and Dai 2004; Cho et al. 2024).

Previously, species within *Collybiopsis* were included within *Collybia* s. l. (Petersen and Hughes 2024). With the advancement of phylogenetic studies on *Collybia* s. l., the concept of *Collybia* s. s. was redefined, and the remaining taxa were transferred to *Collybiopsis*, *Gymnopus* (Pers.) Gray, and *Marasmiellus* Murrill (Oliveira et al. 2019; Razzaq et al. 2023; Petersen and Hughes 2024). However, both *Gymnopus* and *Marasmiellus* are polyphyletic in the phylogenetic analysis (Oliveira et al. 2019). Currently, the redefined *Collybiopsis* includes species of *Collybiopsis*, some species of *Gymnopus* sect. *Vestipedes*, and *Marasmiellus* (Petersen and Hughes 2021; Kim et al. 2022; Razzaq et al. 2023).

In China, 25 species of *Collybiopsis* have been reported, including nine new species described from Yunnan and Guangdong provinces and Guangxi and Xizang Autonomous Regions (Zhang et al. 2023b; Li et al. 2024; Liu et al. 2024; Liu et al. 2025a). During surveys in the subtropical regions of China, several species with characteristics of *Collybiopsis* were found that do not correspond to any described species. Based on morphological comparisons and phylogenetic analyses, four of these species were further confirmed as new species of *Collybiopsis*.

Materials and methods

Morphological study

Specimens are deposited in the Herbarium of Fungi, Jiangxi Agricultural University (HFJAU). The specimens were collected from 2021 to 2024 and stored in dried condition. Macroscopic characteristics were recorded from fresh specimens. The color codes were referenced from the Methuen Handbook of Colour (Kornerup and Wanscher 1978). Micromorphological structures were observed and measured under an Olympus BX53 microscope (Olympus Corporation, Tokyo, Japan) by making squash preparations of sections of dried specimens that were placed in 5% KOH solution or H_2O, and 1% Congo red was used as the staining agent for observing colorless tissues. Melzer's reagent was selected for determining whether the spores were amyloid or not (Horak 2005; Chen et al. 2024). At least 20 basidiospores, basidia, and cystidia were measured for each collection. The range of spore size is expressed in the format (a) b–c (d), where "a" and "d" represent the minimum and maximum values, and 90% of the spores fall within the range "b–c". The basidiospore quotient (Q = length / width) was calculated based on the measurements of basidiospores. The meanings of the other spore characteristics are as follows: "av" symbolizes average value; "n" means the number of measured spores; and "Qm" indicates the standard deviation of "Q" (Bas 1969; Chen et al. 2024).

DNA extraction, PCR amplification, and sequencing

Genomic DNA was extracted from dried specimens using the NuClean Plant Genomic DNA kit (CWBIO, China). The ITS and LSU regions were amplified

separately using the primer pairs of ITS1F/ITS4 (White et al. 1990; Gardes and Bruns 1993) and LR0R/LR5 or LR7, respectively (Vilgalys and Hester 1990).

PCR amplification was conducted using a 25 μL reaction system as follows: 1 μL of DNA, 1 μL of each primer, 9.5 μL of ddH_2O, and 12.5 μL of 2× TaqMaster Mix [Qing Ke Biotechnology Co. Ltd. (Wuhan City, China)]. PCR was performed using a touchdown program for all regions: initial 95 °C for 5 min, and then 14 cycles of denaturing at 95 °C for 30 s, annealing at 65 °C for 45 s (with a decrease of 1 °C per cycle), extension at 72 °C for 1 min, and then 30 cycles of denaturing at 95 °C for 30 s, annealing at 52 °C for 30 s, and extension at 72 °C for 1 min, with the final extension at 72 °C for 10 min (Bau and Yan 2021; Chen et al. 2024). The PCR products were sequenced by Qing Ke Biotechnology Co. Ltd. (Wuhan City, China).

Alignment and phylogenetic analyses

In total, 255 sequences (156 ITS sequences and 99 LSU sequences) of 156 samples were used for phylogenetic analyses based on ML and BI. The selection of sequences for the phylogenetic analyses was based on the results of ITS BLAST and studies by Petersen and Hughes (2021) and Kim et al. (2022) (Table 1). Following the research of Kim et al. (2022), *Rhodocollybia butyracea* (Bull.) Lennox and *R. maculata* (Alb. & Schwein.) Singer were selected as outgroups.

The ITS and LSU sequence datasets were separately aligned on the MAFFT online server (Katoh et al. 2019). The processed sequences were subjected to BI and ML phylogenetic analyses using MrBayes v.3.2.7a and IQ-Tree v.2.1.2, respectively (Nguyen et al. 2015). The best-fit models for ML and BI were determined by PartitionFinder (Kalyaanamoorthy et al. 2017), according to the Corrected Akaike Information Criterion (AICc). For the ML analysis, 5,000 replicates were performed based on the ultrafast bootstrap option of ML, which allowed partitions from different seeds. For the BI analysis, the four Monte Carlo Markov chains were set to run for one billion generations, with the computation terminating when the average standard deviation of split frequencies was less than 0.01. The first 25% of the trees were discarded as burn-in. Branches with Bayesian posterior probability (BI-PP) ≥ 0.95 and ML bootstrap support (ML-BP) ≥ 75% are shown in the tree (Fig. 1). All alignments for phylogenetic analyses and the resulting trees were deposited in TreeBASE (ID: 32185, http://purl.org/phylo/treebase/phylows/study/TB2:S32185?x-access-code=30c9f648f6ffbf8543353756fb3d5ef4&format=html).

Results

Phylogenetic analysis

For the phylogenetic analyses, a total of 2,103 characters were used in the analyses, of which 1,249 were constant, 708 were parsimony-informative, and 146 were singleton. The best-fit models used for the phylogenetic analyses were as follows: GTR+F+I+G4 for ITS and HKY+F+I+G4 for LSU. The log-likelihood value of the ML consensus tree was −20,599.090. And the average standard deviation of split frequencies was < 0.01 after 3,350,000 generations in the BI analysis.

Table 1. A list of species and sequences used in the phylogenetic analyses. Newly generated sequences are in bold.

Species	Location	Voucher Number	GenBank Number		Sequence reference
			ITS	LSU	
Collybiopsis affixa	Australia	FT0004B	PP508259	–	Unpublished in GenBank
Collybiopsis albicantipes	Korea	SFC20170725-35 Holotype	OL467272	OL462811	Kim et al. (2022)
Collybiopsis albicantipes	Korea	SFC20180704-86	OL467273	OL462812	Kim et al. (2022)
Collybiopsis alpina	China	HMJAU 60410 Holotype	PP151538	PP151568	Li et al. (2024)
Collybiopsis alpina	China	HMJAU 60411	PP151537	–	Li et al. (2024)
Collybiopsis attenuata	China	HMAS296736 Holotype	PP741392	–	Unpublished in GenBank
Collybiopsis baiyunensis	China	GDGM93885 Holotype	OR598795	OR598808	Liu et al. (2024)
Collybiopsis baiyunensis	China	GDGM93886	OR598792	OR598809	Liu et al. (2024)
Collybiopsis bambusicola	China	BJFC 032412 Holotype	MW969675	ON697204	Zhang et al. (2023b)
Collybiopsis biformis	USA	TFB14251	KJ416245	KJ189567	Petersen and Hughes (2014)
Collybiopsis biformis	USA	TFB14250	KJ416246	KJ189568	Petersen and Hughes (2014)
Collybiopsis biformis	USA	TFB13814	KJ416249	KJ189569	Petersen and Hughes (2014)
Collybiopsis biformis	USA	TFB13890	KJ416248	KJ189570	Petersen and Hughes (2014)
Collybiopsis billbowesii	Africa	SFSU DED 8250 Holotype	MF100989	–	Desjardin and Perry (2017)
Collybiopsis brunneigracilis	Java/Bali	AWW01	AY263434	AY639412	Unpublished in GenBank
Collybiopsis californica	Canada	TENN-F-052617	MN413338	–	Petersen and Hughes (2021)
Collybiopsis carneopallida	Italy	BRNM 747442	OM522632	–	Antonín et al. (2022)
Collybiopsis cimrmanii	Portugal	BRNM 828679 Holotype	MW924062	OM333232	Unpublished in GenBank
Collybiopsis cimrmanii	Portugal	BRNM 828680	MW924061	OM333231	Unpublished in GenBank
Collybiopsis clavicystidiata	Korea	SFC20180705-26	OL467250	OL462816	Kim et al. (2022)
Collybiopsis clavicystidiata	Korea	SFC20180705-84 Holotype	OL467252	OL462817	Kim et al. (2022)
Collybiopsis clavicystidiata	Korea	SFC20180713-09	OL467251	OL462819	Kim et al. (2022)
Collybiopsis complicata	USA	TENN-F-055766 Holotype	DQ450029	–	Mata et al. (2007)
Collybiopsis complicata	USA	TENN-F-065811	OR500517	OR500517	Unpublished in GenBank
Collybiopsis confluens	Canada	TFB14409 Holotype	KP710278	KJ189585	Hughes and Petersen (2015)
Collybiopsis confluens	Canada	TFB14389	KP710279	KJ189584	Hughes and Petersen (2015)
Collybiopsis confluens	USA	TFB14075	KP710281	KJ189581	Hughes and Petersen (2015)
Collybiopsis cylindrica	Costa Rica	TENN 058097 Holotype	NR_119464	–	Schoch et al. (2014)
Collybiopsis dentata	**China**	**HFJAU2586 Holotype**	**PV424096**	**–**	**This work**
Collybiopsis dentata	**China**	**HFJAU5718**	**PV424098**	**–**	**This work**
Collybiopsis diaphana	Mexico	Cesar202 Holotype	MT232390	–	César et al. (2020)
Collybiopsis dichroa	USA	TFB9623	MW396865	MW396865	Petersen and Hughes (2021)
Collybiopsis disjuncta	USA	TENN 69172 Holotype	NR_137865	–	Petersen and Hughes (2014)
Collybiopsis disjuncta	USA	TFB14281	KJ416253	KY019643	Petersen and Hughes (2014)
Collybiopsis eneficola	Canada	TENN 69123 Holotype	NR_137613	NG_059502	Petersen et al. (2014)
Collybiopsis eneficola	Canada	100921AV04	KJ128265	KJ189590	Petersen et al. (2014)
Collybiopsis eneficola	Alaska	MICH PK6975	KP710270	KP710304	Hughes and Petersen (2015)
Collybiopsis filamentipes	USA	TFB13962 Holotype	MN897832	MN897832	Petersen and Hughes (2021)
Collybiopsis foliiphila	India	CUH AM090 Holotype	NR_154176	NG_060320	Dutta et al. (2015)
Collybiopsis foliiphila	India	CUM AM101	KP317638	KP317636	Dutta et al. (2015)
Collybiopsis fucata	**China**	**HFJAU2535 Holotype**	**PV424094**	**–**	**This work**
Collybiopsis fucata	**China**	**HFJAU5343**	**PV424095**	**PV366624**	**This work**
Collybiopsis fulva	Korea	KA13-0216	OL467257	OL462793	Kim et al. (2022)
Collybiopsis fulva	Korea	KA13-0333	OL467258	OL462794	Kim et al. (2022)
Collybiopsis fulva	Korea	KA15-0210 Holotype	OL467259	OL462795	Kim et al. (2022)
Collybiopsis furtiva	USA	TENN-F-051097	MN413343	MW396879	Petersen and Hughes (2021)
Collybiopsis gibbosa	Australia	MEL 2382838	KP012713	–	Unpublished in GenBank
Collybiopsis gibbosa	Brazil	URM 90012	KY061202	KY061202	Unpublished in GenBank
Collybiopsis gibbosa	Brazil	URM 90006	KY061203	KY061203	Unpublished in GenBank
Collybiopsis hasanskyensis	Russia	TFB11846	MN897829	–	Petersen and Hughes (2021)
Collybiopsis hirtelloides	Africa	SFSU DED 8318 Holotype	MF100975	–	Desjardin and Perry (2017)

Species	Location	Voucher Number	GenBank Number		Sequence reference
			ITS	LSU	
Collybiopsis humillima	unknown	DA-22 029	OQ850983	–	Unpublished in GenBank
Collybiopsis incarnata	China	Liu 1236 Holotype	PQ638405	PQ637004	Liu et al. (2025a)
Collybiopsis incarnata	China	Liu 1240	PQ638406	PQ637005	Liu et al. (2025a)
Collybiopsis indoctus	Java/Bali	AWW04	AY263439	–	Unpublished in GenBank
Collybiopsis istanbulensis	Turkey	KATO Fungi 3596	KX184795	KX184796	Sesli et al. (2018)
Collybiopsis juniperina	USA	TFB9889	AY256708	KY019637	Mata et al. (2004)
Collybiopsis juniperina	Argentina	TFB10782	KY026661	KY026661	Petersen and Hughes (2016)
Collybiopsis koreana	Korea	SFC20120821-84	OL467269	OL546545	Kim et al. (2022)
Collybiopsis koreana	Korea	SFC20150721-10	OL467271	OL462802	Kim et al. (2022)
Collybiopsis latispora	**China**	**HFJAU3109 Holotype**	**PV424097**	**PV366626**	**This work**
Collybiopsis luxurians	Korea	NIBRFG0000502888	OL467248	OL462803	Kim et al. (2022)
Collybiopsis luxurians	Korea	SFC20190731-18	OL467249	OL462804	Kim et al. (2022)
Collybiopsis luxurians	USA	TFB10350	AY256709	AY256709	Mata et al. (2004)
Collybiopsis luxurians	Sweden	TFB4283-10	KJ416240	–	Petersen and Hughes (2014)
Collybiopsis luxurians	USA	TFB9121	KY026649	KY026649	Petersen and Hughes (2016)
Collybiopsis luxurians	USA	TFB14060	MW396871	MW396871	Petersen and Hughes (2021)
Collybiopsis medogensis	China	Liu 1048	PQ638400	PQ636999	Liu et al. (2025a)
Collybiopsis medogensis	China	Liu 1055 Holotype	PQ638399	PQ636998	Liu et al. (2025a)
Collybiopsis melanopus	Java/Bali	AWW54 Holotype	NR_137539	NG_060624	Unpublished in GenBank
Collybiopsis melanopus	India	CUH AM093	KM896875	–	Dutta et al. (2015)
Collybiopsis menehune	USA	AWW15	AY263443	AY639424	Unpublished in GenBank
Collybiopsis mesoamericana	Costa Rica	TFB11005	DQ450035	KY019632	Mata et al. (2007)
Collybiopsis mesoamericana	Costa Rica	TFB10411	DQ450036	–	Mata et al. (2007)
Collybiopsis mesoamericana	Costa Rica	REH7379	AF505768	–	Mata et al. (2007)
Collybiopsis micromphaleoides	USA	TENN 68165 Holotype	NR_137864	NG_059734	Petersen and Hughes (2014)
Collybiopsis micromphaleoides	USA	TFB14282	KJ416243	KY019645	Petersen and Hughes (2014)
Collybiopsis minor	USA	TENN-F-059993	MN413334	MW396880	Petersen and Hughes (2021)
Collybiopsis minor	USA	TFB5434	MW396872	MW396872	Petersen and Hughes (2021)
Collybiopsis minor	USA	TFB6284	MW405778	–	Petersen and Hughes (2021)
Collybiopsis mustachia	Africa	SFSU BAP 670 Holotype	MF100987	–	Desjardin and Perry (2017)
Collybiopsis neotropica	Costa Rica	TFB10416	AF505769	–	Unpublished in GenBank
Collybiopsis nonnulla	USA	TFB14492	MW396873	MW396873	Petersen and Hughes (2021)
Collybiopsis nonnulla	USA	TFB14278	KY026701	KY026701	Petersen and Hughes (2016)
Collybiopsis obscuroides	Norway	GB-0150514	KX958399	KX958399	Unpublished in GenBank
Collybiopsis ocella	Africa	SFSU DED 8280 Holotype	MF100976	–	Desjardin and Perry (2017)
Collybiopsis omphalodes	Costa Rica	TFB 10427	DQ450011	–	Mata et al. (2007)
Collybiopsis omphalodes	Costa Rica	TENN56734	AY256700	–	Mata et al. (2004)
Collybiopsis orientisubnuda	Korea	NIBRFG0000500990 Holotype	OL467262	–	Kim et al. (2022)
Collybiopsis orientisubnuda	Korea	SFC20170823-39	OL467263	–	Kim et al. (2022)
Collybiopsis orientisubnuda	Korea	SFC20180830-29	OL467264	–	Kim et al. (2022)
Collybiopsis pakistanica	Pakistan	LAH 37522 Holotype	OP199106	OP209954	Razzaq et al. (2023)
Collybiopsis parvula	Costa Rica	TFB10419 Holotype	DQ450060	–	Mata et al. (2007)
Collybiopsis parvula	Costa Rica	TFB10421	DQ450061	–	Mata et al. (2007)
Collybiopsis parvula	Costa Rica	TFB10425	DQ450062	–	Mata et al. (2007)
Collybiopsis parvula	Costa Rica	TFB10422	AF505774	–	Mata et al. (2007)
Collybiopsis peronata	Belgium	TFB13743	KY026677	KY026677	Petersen and Hughes (2016)
Collybiopsis peronata	Russia	LE-Bin1364	KY026755	KY026755	Petersen and Hughes (2016)
Collybiopsis peronata	unknown	CBS 223.37	MH855896	MH867405	Vu et al. (2019)
Collybiopsis peronata	Canada	UBCF28402	KP454027	–	Unpublished in GenBank
Collybiopsis pleurocystidiata	Africa	SFSU BAP 651 Holotype	MF100977	–	Desjardin and Perry (2017)
Collybiopsis polygramma	Brazil	URM 90015	KY074640	KY088275	Unpublished in GenBank
Collybiopsis polygramma	Puerto Rico	PR2542TN	AY842954	–	López-Ferrer (2004)
Collybiopsis polygramma	Brazil	URM 90016	KY074641	KY088274	Unpublished in GenBank

Species	Location	Voucher Number	GenBank Number		Sequence reference
			ITS	LSU	
Collybiopsis prolapsis	USA	TENN-F-051101	MW396874	MW396874	Petersen and Hughes (2021)
Collybiopsis pseudoluxurians	Costa Rica	REH7348	AF505762	–	Mata et al. (2007)
Collybiopsis pseudoluxurians	Puerto Rico	PR24TN	AY842957	–	López-Ferrer (2004)
Collybiopsis quercophila	USA	TFB14615	KY026736	KY026736	Petersen and Hughes (2016)
Collybiopsis quercophila	USA	SFSU25220	KY026761	KY026761	Petersen and Hughes (2016)
Collybiopsis ramealis	Belgium	TENN-F-065145 Epitype	MN413345	MN413345	Petersen and Hughes (2021)
Collybiopsis ramealis	Sweden	TFB4727	DQ450030	–	Mata et al. (2007)
Collybiopsis ramealis	Belgium	TFB13755	KJ416235	KJ189566	Petersen and Hughes (2014)
Collybiopsis ramealis	Belgium	TENN-F-065146	MN413346	MW396882	Petersen and Hughes (2021)
Collybiopsis cf. *ramealis*	Korea	SFC20180829-20	OL467261	OL546548	Kim et al. (2022)
Collybiopsis ramulicola	China	GDGM 43884	KU057798	–	Deng et al. (2016)
Collybiopsis ramulicola	China	GDGM 44256	KU321529	–	Deng et al. (2016)
Collybiopsis ramulicola	China	GDGM 50060	KU321530	–	Deng et al. (2016)
Collybiopsis readiae	New Zealand	TFB7571	DQ450034	–	Mata et al. (2007)
Collybiopsis readiae	New Zealand	PDD95844	HQ533036	–	Unpublished in GenBank
Collybiopsis readiae	New Zealand	TFB13056	KJ416244	–	Petersen and Hughes (2014)
Collybiopsis rodhallii	Africa	SFSU BAP 627 Holotype	MF100982	–	Desjardin and Perry (2017)
Collybiopsis salmonea	China	Liu 1187 Holotype	PQ638404	PQ637003	Liu et al. (2025a)
Collybiopsis salmonea	China	Liu 1166	PQ638401	PQ637000	Liu et al. (2025a)
Collybiopsis schizophylloides	China	HMJAU 60446 Holotype	PP133256	PP133257	Li et al. (2024)
Collybiopsis stenophylla	USA	TENN-F-065943	MN413331	MW396886	Petersen and Hughes (2021)
Collybiopsis stenophylla	USA	TENN-F-051099	MN413330	MW396887	Petersen and Hughes (2021)
Collybiopsis stenophylla	USA	TFB11558	DQ450032	–	Mata et al. (2007)
Collybiopsis subcyathiformis	Puerto Rico	TFB9629	DQ450041	–	Mata et al. (2007)
Collybiopsis subcyathiformis	Brazil	URM 90023	KY404982	KY404982	Unpublished in GenBank
Collybiopsis subcyathiformis	Brazil	URM 90022	KY404983	KY404983	Unpublished in GenBank
Collybiopsis submenehune	China	Liu 725 Holotype	PQ638396	PQ636995	Liu et al. (2025a)
Collybiopsis subnuda	USA	TFB12577	KY026667	–	Petersen and Hughes (2016)
Collybiopsis subnuda	USA	WRW 08-462	KY026765	KY026765	Petersen and Hughes (2016)
Collybiopsis subnuda	USA	TFB14043	MW396876	MW396876	Petersen and Hughes (2021)
Collybiopsis subpruinosus	Portugal	BRNM781138	MK646034	–	Unpublished in GenBank
Collybiopsis subpruinosus	USA	TFB11063	DQ450025	–	Mata et al. (2007)
Collybiopsis subpolygramma	**China**	**HFJAU2658 Holotype**	**PV424091**	**–**	**This work**
Collybiopsis subpolygramma	**China**	**HFJAU3277**	**PV424092**	**PV366625**	**This work**
Collybiopsis subpolygramma	**China**	**HFJAU3551**	**PV424093**	**–**	**This work**
Collybiopsis subumbilicata	Korea	SFC20120802-03	OL467231	OL462786	Kim et al. (2022)
Collybiopsis subumbilicata	Korea	SFC20140701-03 Holotype	OL467232	OL462787	Kim et al. (2022)
Collybiopsis subumbilicata	Korea	SFC20150902-50	OL467234	OL546540	Kim et al. (2022)
Collybiopsis tayloriae	Australia	BRIP 76156a Holotype	PP707900	PP707919	Unpublished in GenBank
Collybiopsis termiticola	Java and Bali	AWW106	AY263451	AY639430	Unpublished in GenBank
Collybiopsis trogioides	Indonesia	AWW51	AY263428	AY639431	Unpublished in GenBank
Collybiopsis undulata	Korea	SFC20130808-08	OL467240	OL462814	Kim et al. (2022)
Collybiopsis undulata	Korea	SFC20150813-04	OL467241	OL462815	Kim et al. (2022)
Collybiopsis utriformis	USA	TFB14334	KY026708	KY026708	Petersen and Hughes (2016)
Collybiopsis utriformis	USA	WRW05-1170	KY026764	KY026764	Petersen and Hughes (2016)
Collybiopsis vaillantii	USA	TENN–F–065115	KY026676	KY026676	Petersen and Hughes (2016)
Collybiopsis vellerea	Korea	NIBRFG0000502858	OL467265	OL462791	Kim et al. (2022)
Collybiopsis vellerea	Korea	SFC20120708-02	OL467266	OL462809	Kim et al. (2022)
Collybiopsis villosipes	USA	TFB9539	DQ450058	–	Mata et al. (2007)
Collybiopsis villosipes	New Zealand	TFB12836	KJ416255	–	Petersen and Hughes (2014)
Outgroup					
Rhodocollybia butyracea	Canada	TFB 14382	KY026716	KY026716	Petersen and Hughes (2016)
Rhodocollybia maculata	USA	TFB 13989	KY026688	KY026688	Petersen and Hughes (2016)

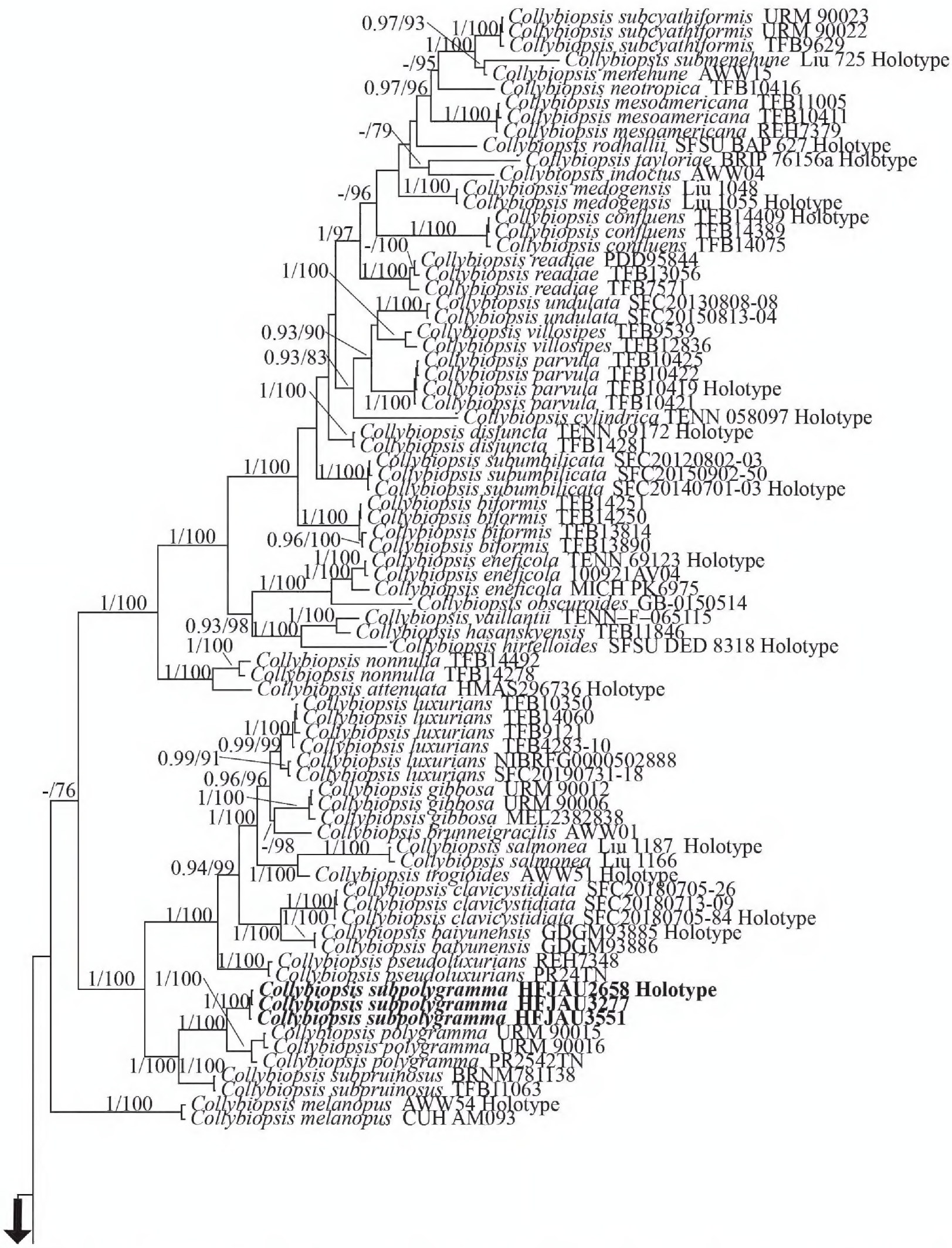

Figure 1. Phylogram of *Collybiopsis* generated by Bayesian inference (BI) analysis based on ITS and LSU, with *Rhodocollybia* spp. designated as the outgroup. Bayesian posterior probabilities (BI-PP) ≥ 0.95 and maximum likelihood bootstrap proportions (ML-BP) ≥ 75 are indicated as PP/BP. New taxa are marked in bold.

As shown in the phylogenetic tree in Fig. 1, four new species each formed a well-supported monophyletic lineage (BI-PP = 1; ML-BP = 100%). *Collybiopsis subpolygramma* formed a sister lineage with *C. polygramma* (Mont.) R.H. Petersen (BI-PP = 1, ML-BP = 100%). *Collybiopsis fucata*, *C. latispora*, and *C. dentata* were all nested within the *C. ramealis* complex. Among them, *C. fucata* formed a sister lineage with *C. latispora* (BI-PP = 1, ML-BP = 100%). *Collybiopsis dentata* formed a stable branch on its own (BI-PP = 1, ML-BP = 100%).

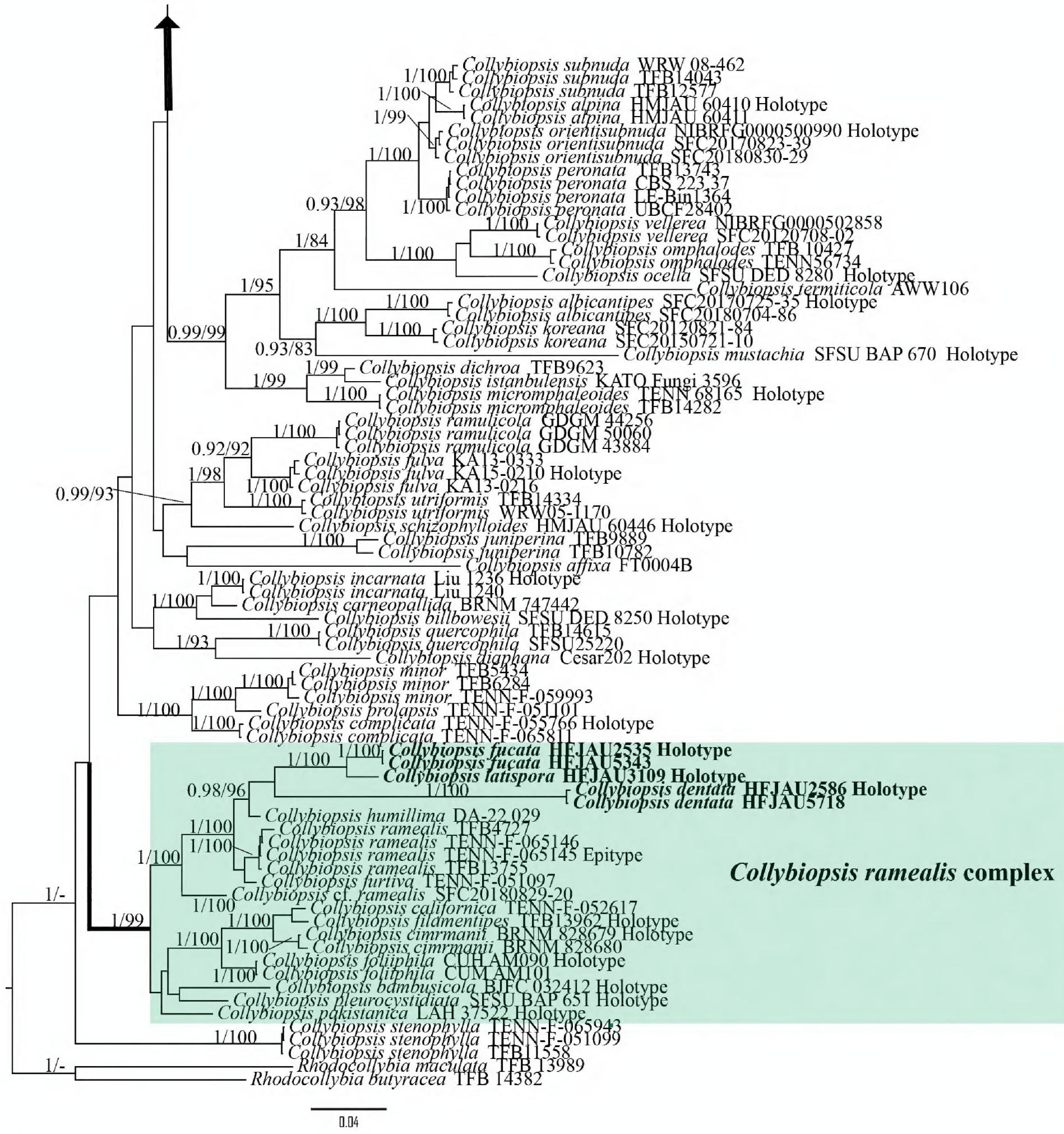

Figure 1. Continued.

Taxonomy

Collybiopsis subpolygramma **J.Q. Yan, L. Ding, & S.N. Wang, sp. nov.**

MycoBank No: 858728

Fig. 2

Etymology. Referring to its similarity to *C. polygramma*, that pileus is sulcate.

Holotype. CHINA • Zhejiang Province, Lishui City, Qingtian County, Lanni Lake, 1 August 2021, Jun-Qing Yan, Bin-Rong Ke and Zhi-Heng Zeng, HFJAU2658.

Diagnosis. This species is characterized by its pileal surface, white in color with a light brown center; crowded and occasionally forked lamellae; white to black-brown stipe; slender cylindrical cheilocystidia; basidia mainly 2-spored; and absence of pleurocystidia.

Macrostructures. Pileus 32–61 mm in diam., convex to plane, becoming uplifted in age, umbonate at disc, surface smooth, sulcate up to center from the margin, light brown (7D5–6) at the center, gradually becoming lighter towards the margin, margin white. Lamellae adnexed, occasionally forked, crowded, with 1–3 types of lamellulae, white. Stipe 49–68 × 2.4–4.2 mm, central, hollow, cylindrical, equal, white to black-brown (8F5), surface covered with white fibrils, base covered with white mycelium.

Microstructures. Basidiospores in side view [n = 115] (5.9)6.4–8.1(8.7) × (3.7)4.1–5.1(5.2) µm (av = 7.2 × 4.6 µm, Q = 1.4–1.8(2.0) (Qm = 1.6 ± 0.1), ellipsoid to elongated-ellipsoid, in profile slightly curved or flattened on one side; in face view (3.7)4.0–5.0(5.1) µm broad, ellipsoid to elongated-ellipsoid, thin-walled, hyaline, non-amyloid. Basidia 24–34 × 5.6–7.9 µm, clavate, 2-spored, occasionally 4-spored. Pleurocystidia absent. Cheilocystidia 21–50 × 5.9–8.6 µm, abundant, slender cylindrical, occasionally fusiform, apex obtuse, occasionally mucronate or capitate, sometimes with small tubercles, thin-walled, hyaline. Pileipellis a cutis, hyphal cells 2.9–9.9 µm broad. Stipitipellis a cutis, hyphal cells 4.0–9.7 µm broad, thin-walled. Caulocystidia 29–100 × 5.1–8.4 µm, abundant, slender cylindrical, apex obtuse or capitate, thin-walled. Clamp connections present.

Habitat. Scattered or gregarious on the ground in mixed broad-leaved forests.

Distribution. China.

Additional specimens examined. CHINA • Fujian Province: Wuyishan City, Daliankeng, 6 June 2022, Jun-Qing Yan and Lin-Gen Chen, HFJAU3551; Zhejiang Province: Lishui City, Qingtian County, Lanni Lake, 1 August 2021, Jun-Qing Yan, Bin-Rong Ke and Zhi-Heng Zeng, HFJAU2644; Qingtian, 31 August 2021, Ya-Ping Hu, HFJAU3277.

Remarks. *Collybiopsis subpolygramma* is morphologically similar to *G. coracicolor* (Berk. & M.A. Curtis) J.L. Mata, *G. hondurensis* (Murrill) J.L. Mata, *C. neotropica* (Singer) R.H. Petersen and *C. polygramma*, all of which have a cutis of pileipellis without rameales-type structure, similarly shaped basidiospores, and the absence of pleurocystidia. However, *G. coracicolor* has smaller pileus (shorter than 25 mm), larger cheilocystidia (70 × 8–10 µm), and brown incrustation on the pileipellis hyphae (Dennis 1951). *Gymnopus hondurensis* has four-spored basidia and clavate cheilocystidia (Mata and Ovrebo 2009). *Collybiopsis neotropica* has smaller pileus (shorter than 23 mm), larger basidiospores (8.2–9.7 × 4.3–4.8 µm), larger basidia (29–32 × 6.8–9.7 µm) with four spores, and irregular, filamentous cheilocystidia (Singer 1961). *Collybiopsis polygramma* has smaller pileus (shorter than 25 mm) with a distinct umbilicate, absence of cheilocystidia, and hyphae of stipe are thick-walled, up to 3 µm (Mata and Petersen 2003).

Additionally, *G. lodgeae* (Singer) J.L. Mata also has a cutis of pileipellis without rameales-type structure and similarly shaped basidiospores. However, *G. lodgeae* has a smaller pileus (shorter than 20 mm), larger cheilocystidia (32–56 × 10–14 µm), and the presence of pleurocystidia (Mata and Petersen 2003).

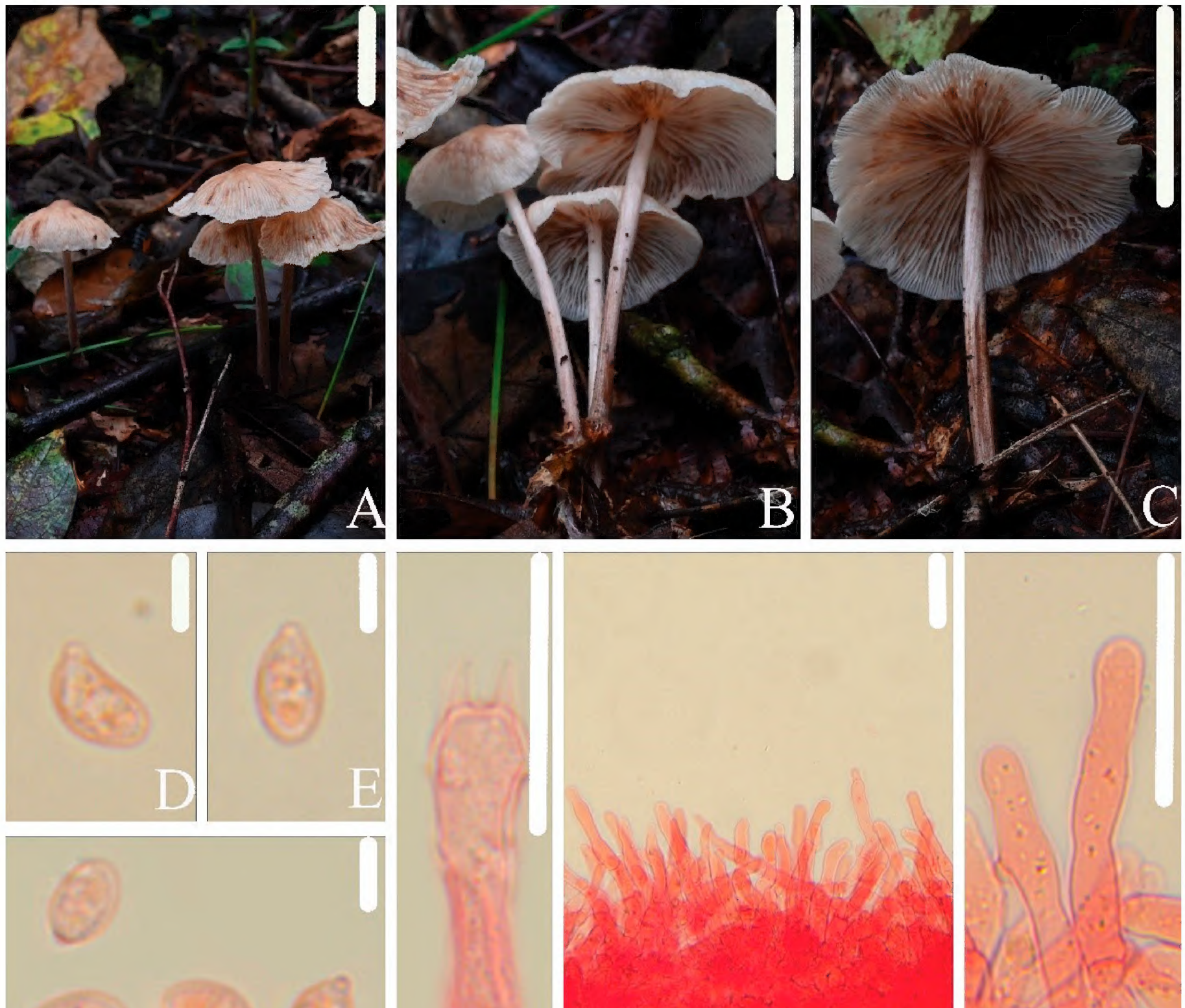

Figure 2. *Collybiopsis subpolygramma*. **A–C.** Basidiomata; **D–F.** Basidiospores; **G.** Basidia; **H–J.** Cheilocystidia; **K.** Pileipellis; **L.** Caulocystidia. All microscopic structures were observed in 5% KOH, and 1% Congo red was used as the stain. Scale bars: 30 mm (**A–C**); 5 μm (**D–F**); 20 μm (**G**); 30 μm (**H–I**); 20 μm (**J**); 30 μm (**K, L**).

Collybiopsis fucata **J.Q. Yan, L. Ding, & S.N. Wang, sp. nov.**

MycoBank No: 858729

Fig. 3

Etymology. Refer to the Latin "fucatus," meaning "painted"—the lamellae edges are fucata.

Holotype. CHINA • Zhejiang Province, Lanni Lake, Qingtian County, Lishui City, 6 July 2021, Jun-Qing Yan, HFJAU2535.

Diagnosis. This species is characterized by the reddish-brown, hygrophanous pileus; white lamellae that are adnate to adnexed; reddish-brown stipe with a white apex; basidiospores 3.9–5.2 µm broad; fusiform to utriform pleurocystidia; and cheilocystidia 25–65 × 11–31 µm.

Macrostructures. Pileus 6.5–14 mm in diam., hemispherical when young, then becoming convex, applanate when mature, umbilicate at center, margin entire, surface smooth or with striations, hygrophanous, reddish-brown (8D4–5), with color fading from the center to the margin and gradually paling from the margin to the center as the hygrophanous effect disappears, center light brown (7D5–6). Lamellae adnate to slightly adnexed, distant, with 1–2 types of lamellulae, white, with entire edges, concolorous with the lamellae. Stipe 4.0–8.9 × 0.5–1.0 mm, central, hollow, cylindrical, equal, darkening towards the base, white at the apex to reddish-brown (8E5–6) at the base, surface covered with white fibrils, no white mycelium observed at the base.

Microstructures. Basidiospores in side view [n = 118] (6.7)7.0–9.1(9.7) × (3.3)3.9–5.2(5.4) µm (av = 8.1 × 4.4 µm, Q = (1.5)1.6–2.1(2.2) (Qm = 1.8 ± 0.1), ellipsoid to elongated-ellipsoid, in profile slightly curved or flattened on one side; in face view 4.0–5.0(5.1) µm broad, ellipsoid to elongated-ellipsoid, thin-walled, hyaline, non-amyloid. Basidia 21–30 × 5.4–8.5 µm, clavate, 4- or 2-spored. Pleurocystidia 17–34 × 4.2–8.0 µm, abundant, fusiform, utriform, thin-walled, hyaline. Cheilocystidia 25–65 × 11–31 µm, abundant, with pedicellate spherical shapes, occasionally broad club-shaped or clavate, with short protuberances on the surface and occasionally branched, with pedicel 2.5–7.5 µm broad, branches 2.6–15 × 1.1–3.1 µm, thin-walled, hyaline. Pileipellis a cutis, with rameales-type structure, hyphal cells 2.1–8.6 µm broad. Stipitipellis a cutis, with numerous small protrusions on the hyphae, hyphal cells 2.9–13 µm broad, protrusions 3.2–13 × 1.5–6.1 µm, thin-walled. Clamp connections present.

Habitat. Scattered or gregarious on decaying wood in mixed forests and broad-leaved forests.

Distribution. China.

Additional specimens examined. CHINA • Hubei Province: Longmenhe Village, Xingshan County, Yichang City, 29 June 2024, Jun-Qing Yan, Lin-Gen Chen, Hong Chen, and Ling Ding, HFJAU5343; Zhejiang Province: Lanni Lake, Qingtian County, Lishui City, 1 August 2021, Jun-Qing Yan, Bin-Rong Ke and Zhi-Heng Zeng, HFJAU2653.

Remarks. *Collybiopsis fucata* is morphologically similar to *C. californica* (Desjardin) R.H. Petersen, *C. filamentipes* R.H. Petersen, and *C. foliiphila* (A.K. Dutta, K. Acharya & Antonín) R.H. Petersen within the *C. ramealis* complex, all having a cutis of pileipellis with rameales-type structure and cheilocystidia with rameales-type structure. However, *C. californica* has a longer stipe (10–46 mm long), narrower basidiospores (3.0–3.3 µm), smaller cheilocystidia (20–42 × 6–20 µm), and

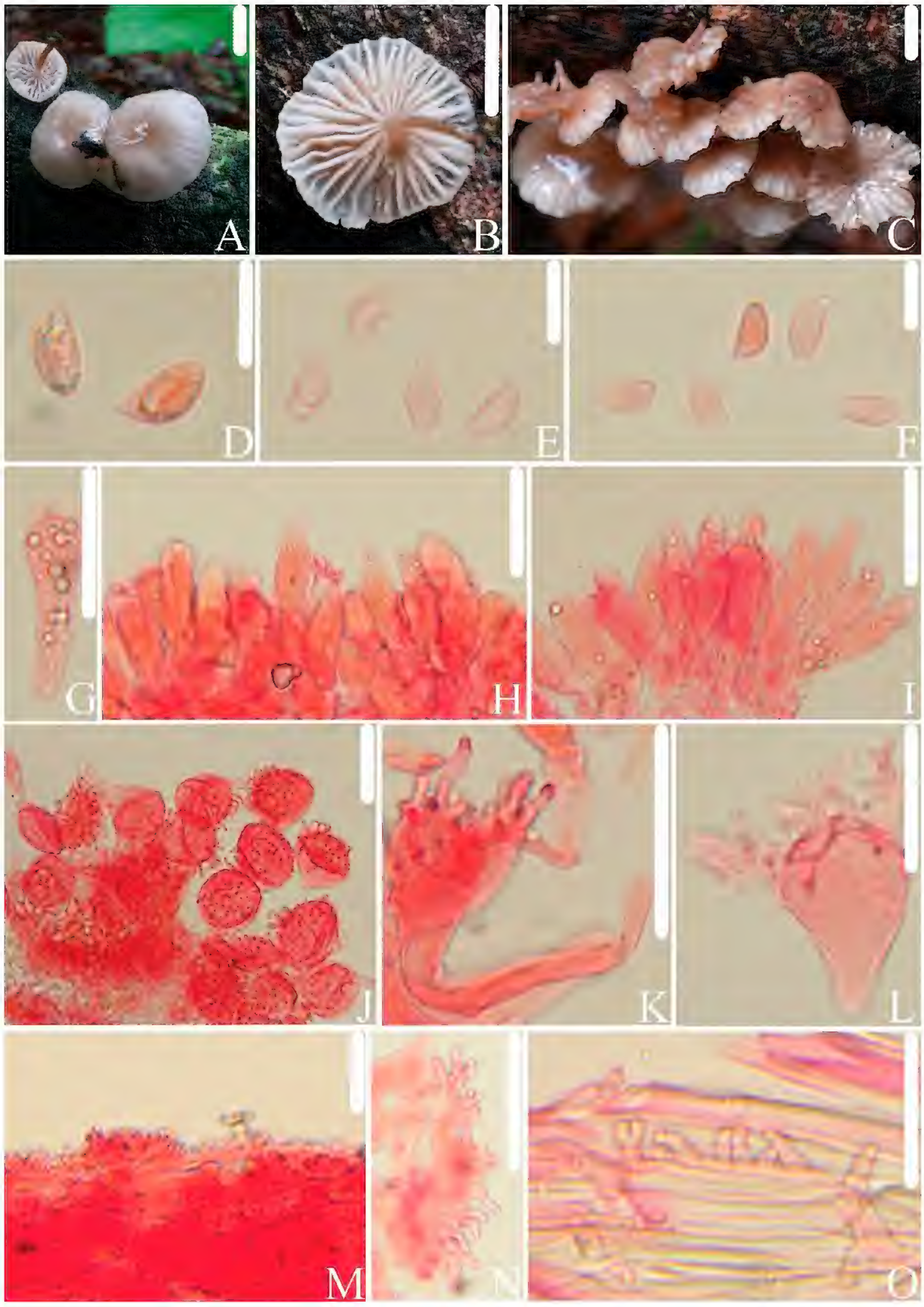

Figure 3. *Collybiopsis fucata*. **A–C.** Basidiomata; **D–F.** Basidiospores; **G.** Basidia; **H–I.** Pleurocystidia; **J–L.** Cheilocystidia; **M, N.** Pileipellis; **O.** Stipitipellis. All microscopic structures were observed in 5% KOH, and 1% Congo red was used as the stain. Scale bars: 5 mm (**A–C**); 10 μm (**D–F**); 20 μm (**G–I**); 30 μm (**J–O**).

absence of pleurocystidia (Desjardin 1987). *Collybiopsis filamentipes* has adnexed to subdecurrent lamellae, a longer stipe (12–21 mm), narrower basidiospores (2.5–3.5 µm), and narrower cheilocystidia (8–18 µm broad), clavate to broad clavate, occasionally stoutly dichotomous (Petersen and Hughes 2021). *Collybiopsis foliiphila* has white pileus, lamellae often with rusty tawny to dark brick-colored spots, narrower basidiospores (3.0–3.7 µm), smaller cheilocystidia (28.6–31 × 9–12 µm), and absence of pleurocystidia (Dutta et al. 2015).

Collybiopsis dentata **J.Q. Yan, L. Ding, & S.N. Wang, sp. nov.**

MycoBank No: 858730

Fig. 4

Etymology. Refer to the Latin "dens," meaning "tooth"—the lamellae edges are dentate.

Holotype. CHINA • Zhejiang Province: Lishui City, Qingtian County, Shigu Lake, 31 July 2021, Jun-Qing Yan, Bin-Rong Ke, Zhi-Heng Zeng, HFJAU2586.

Diagnosis. This species is characterized by white lamellae that are free, basidiospores 3.9–4.7 µm broad, fusiform to utriform pleurocystidia, and cheilocystidia measuring up to 30–71 × 17–29 µm.

Macrostructures. Pileus 3.0–8.5 mm in diam., convex to plane, umbilicate, margin entire, sulcate towards margin, white, light brown (7D5–6) at the center. Lamellae free, distant, with 1–2 types of lamellulae, white, edges serrate, concolorous with the lamellae. Stipe 2.0–4.0 × 0.4–1.0 mm, central, hollow, cylindrical, equal, darkening towards the base, white at the apex to reddish-brown (8E5–6) at the base, surface covered with white pruinose, no white mycelium observed at the base.

Microstructures. Basidiospores in side view [n = 44] (6.3)6.7–8.2(8.6) × (3.8)3.9–4.7(5.0) µm (av = 7.5 × 4.3 µm, Q = 1.6–2.0(2.1) (Qm = 1.7 ± 0.11), elongated-ellipsoid to cylindrical, in profile slightly curved or flattened on one side; in face view 3.9–4.9(5.0) µm broad, elongated-ellipsoid to cylindrical, thin-walled, hyaline, non-amyloid. Basidia 18–26 × 7.0–9.6 µm, clavate, 4- or 2-spored. Pleurocystidia 20–32 × 5.5–8.1 µm, abundant, fusiform, utriform, thin-walled, hyaline. Cheilocystidia (28)30–71(152) × 17–29 µm, abundant, pyriform, with pedicellate spherical shapes, broad clavate, with short projections on the surface, occasionally branched, with pedicel 2.6–7.9 µm broad, branches 3.2–7.6 × 0.6–1.7 µm, thin-walled, hyaline. Pileipellis a cutis, with rameales-type structure, hyphal cells 2.1–14 µm broad. Stipitipellis a cutis, with numerous small protrusions on the hyphae, hyphal cells 2.7–14 µm broad, protrusions 1.5–7.1 × 1.0–5.8 µm, thin-walled. Caulocystidia 8.8–55 × 5.1–14 µm, abundant, cylindrical, surface with protuberances, occasionally branches, branches 1.4–7.4 × 0.9–3.2 µm, thin-walled. Clamp connections present.

Habitat. Gregarious on decaying wood in mixed forests.

Distribution. China.

Additional specimens examined. CHINA • Zhejiang Province: Lishui City, Qingtian County, Shigu Lake, 31 July 2021, Jun-Qing Yan, Bin-Rong Ke, Zhi-Heng Zeng, HFJAU5718.

Remarks. *Collybiopsis dentata* is morphologically similar to *C. californica*, *C. filamentipes*, and *C. foliiphila* within the *C. ramealis* complex, all having a cutis of pileipellis with rameales-type structure and cheilocystidia with

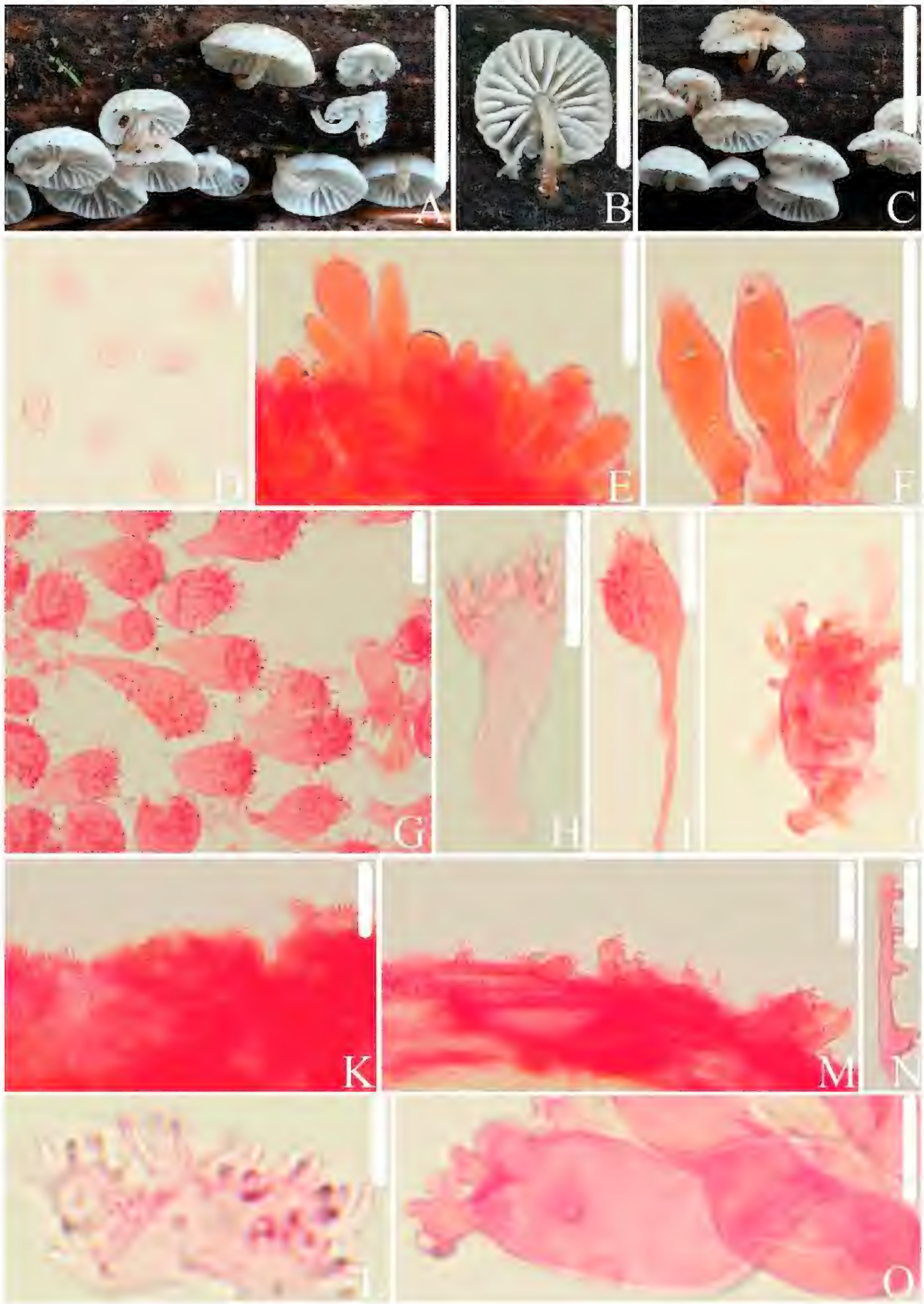

Figure 4. *Collybiopsis dentata*. **A–C.** Basidiomata HFJAU2586, Holotype; **D.** Basidiospore; **E, F.** Pleurocystidia; **G–J.** Cheilocystidia; **K, L.** Pileipellis; **M.** Stipitipellis; **N.** Stipe hyphae; **O.** Caulocystidia. All microscopic structures were observed in 5% KOH, and 1% Congo red was used as the stain. Scale bars: 10 mm (**A**); 5 mm (**B**); 10 mm (**C**); 10 µm (**D**); 20 µm (**E, F**); 30 µm (**G–K**); 10 µm (**L**); 30 µm (**M**); 10 µm (**N, O**).

rameales-type structure. However, *C. californica* has narrower basidiospores (3.0–3.3 µm), smaller cheilocystidia (20–42 × 6–20 µm), and absence of pleurocystidia (Desjardin 1987). *Collybiopsis filamentipes* has adnexed to subdecurrent lamellae, narrower basidiospores (2.5–3.5 µm), narrower cheilocystidia (8–18 µm), smaller caulocystidia (5–20 × 6–9 µm), cylindrical to digitate, and rarely branched (Petersen and Hughes 2021). *Collybiopsis foliiphila* has narrower basidiospores (3.0–3.7 µm), lamellae often with rusty tawny to dark brick-colored spots, smaller cheilocystidia (28.6–31 × 9–12 µm), and absence of pleurocystidia (Dutta et al. 2015).

Collybiopsis latispora **J.Q. Yan, L. Ding, & S.N. Wang, sp. nov.**

MycoBank No: 858731

Fig. 5

Etymology. Refer to the Latin "latus," meaning "broad"—the species having wide basidiospores.

Holotype. CHINA • Fujian Province, Wuyishan Mountain, 12 August 2021, Qin Na, Yu-Peng Gai, HFJAU3109.

Diagnosis. This species is characterized by white lamellae with a minute, snow-white ring or ruff at the stipe base; basidiospores 4.3–5.9 µm broad; subcylindrical, narrow fusiform, narrow utriform pleurocystidia; and cheilocystidia 16–47 × 13–24 µm.

Macrostructures. Pileus 2.5–6.5 mm in diam., convex to plane, margin entire, sulcate towards margin, white, brownish-orange (7C3) at the center. Lamellae adnexed, distant, with 1–2 types of lamellulae, white, edges serrate, concolorous with the lamellae. Stipe 2.1–4.2 × 0.4–0.7 mm, central, hollow, cylindrical, equal, light brown (7D5–6), white at approximately three-quarters of the base, surface covered with white pruinose, with minute snow white ring or ruff on stipe base.

Microstructures. Basidiospores in side view [n = 43] (6.4)6.7–8.1(8.2) × (4.1)4.3–5.9(6.2) µm (av = 7.4 × 4.8 µm, Q = 1.3–1.6(1.8) (Qm = 1.5 ± 0.09), ellipsoid to elongated-ellipsoid, in profile slightly curved or flattened on one side; in face view (4.3)4.5–5.7(7.3) µm broad, broadly ellipsoid, ellipsoid to elongated-ellipsoid, thin-walled, hyaline, non-amyloid. Basidia 16–28 × 5.1–8.6 µm, clavate, 2- or 4-spored. Pleurocystidia 18–37 × 4.4–7.3 µm, abundant, subcylindrical, narrow fusiform, narrow utriform, thin-walled, hyaline. Cheilocystidia 16–47 × 13–24 µm, abundant, pyriform, broad clavate, with pedicellate spherical shapes, with short projections on the surface, occasionally branched, with pedicel 3.1–6.6 µm broad, branches 2.7–11 × 1.2–3.1 µm, thin-walled, hyaline. Pileipellis a cutis, with rameales-type structure, hyphal cells 3.8–9.1 µm broad. Stipitipellis a cutis, hyphal cells 3.3–7.7 µm broad, thin-walled. Caulocystidia 21–47 × 3.4–9.7 µm, abundant, cylindrical, surface with protuberances or branches, thin-walled. Clamp connections present.

Ecology. Scattered on dead branches in mixed forests.

Remarks. *Collybiopsis latispora* is morphologically similar to *C. californica*, *C. filamentipes*, and *C. foliiphila* within the *C. ramealis* complex, all having a cutis of pileipellis with rameales-type structure and cheilocystidia with rameales-type structure. However, *C. californica* has a longer stipe (10–46 mm), narrower basidiospores (3.0–3.3 µm), and absence of pleurocystidia (Desjardin 1987).

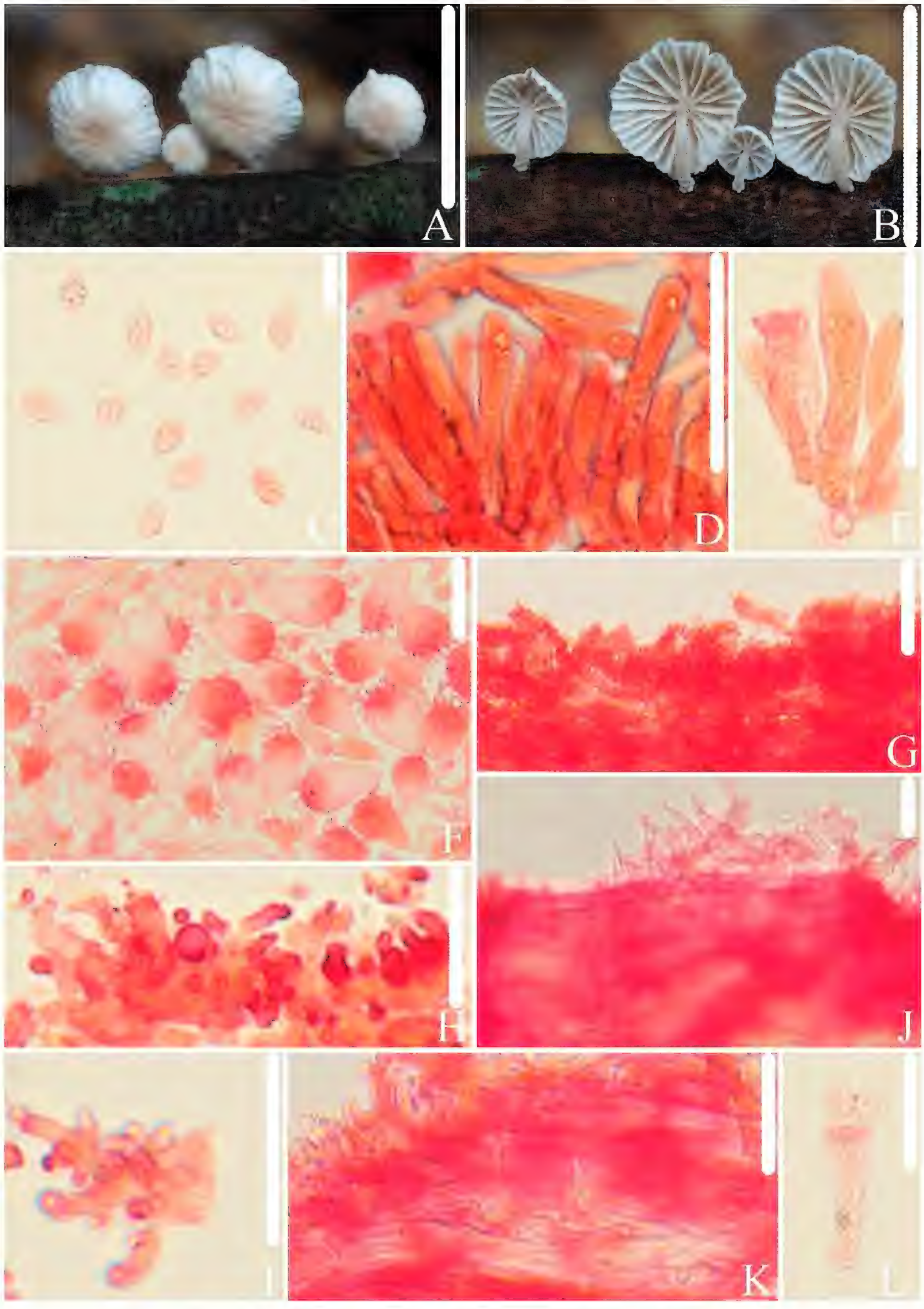

Figure 5. *Collybiopsis latispora*. **A, B.** Basidiomata; **C.** Basidiospores; **D, E.** Pleurocystidia; **F.** Cheilocystidia; **G–I.** Pileipellis; **J, K.** Stipitipellis and Caulocystidia; **L.** Basidia. All microscopic structures were observed in 5% KOH, and 1% Congo red was used as the stain. Scale bars: 10 mm (**A, B**); 10 µm (**C**); 30 µm (**D–G**); 20 µm (**H, I**); 30 µm (**J, K**); 20 µm (**L**).

Collybiopsis filamentipes has a longer stipe (12–21 mm), smooth, narrower basidiospores (2.5–3.5 µm), and cheilocystidia that are typically clavate to broad clavate, occasionally stoutly dichotomous (Petersen and Hughes 2021). *Collybiopsis foliiphila* has lamellae often with rusty tawny to dark brick-colored spots, narrower basidiospores (3.0–3.7 µm), narrower cheilocystidia (9–12 µm), and absence of pleurocystidia (Dutta et al. 2015).

Discussion

Molecularly and morphologically, *C. fucata*, *C. latispora*, and *C. dentata* all belong to the *C. ramealis* complex. In a previous study, this complex included five species, namely *C. foliiphila*, *C. filamentipes*, *C. californica*, *C. furtiva* R.H. Petersen and *C. ramealis* (Petersen and Hughes 2021). The morphological differences between *C. californica*, *C. filamentipes*, *C. foliiphila*, and the new species have been discussed in Remarks. The differences between *C. furtiva*, *C. ramealis*, and the three new species are as follows: *C. furtiva* has narrower basidiospores (2.5–3.0 µm), only fusiform pleurocystidia, narrower cheilocystidia (10–13 µm), adnexed to decurrent lamellae, and fimbriate lamellar edges (Petersen and Hughes 2021). *Collybiopsis ramealis* has a smooth stipe, subdecurrent lamellae, narrower basidiospores (2.5–4.0 µm), and digitate to narrow fusiform pleurocystidia (Petersen and Hughes 2021). In addition, *C. humillima* (Quél.) Argaud conforms to the complex both morphologically and molecularly. However, *C. humillima* has smaller pileus (shorter than 3.5 mm), narrower basidiospores (2.7–3.0 µm), narrower cheilocystidia (6.5–11.5 µm), and only clavate cheilocystidia, which can be clearly distinguished from the three new species (Noordeloos 1983).

Collybiopsis fucata and *C. latispora* formed a sister lineage, but they can be easily distinguished by morphologies. The former has a hygrophanous, reddish-brown pileus; larger cheilocystidia (25–65 × 11–31 µm) with denser surface protuberances; and no minute, snow white ring or ruff on the stipe base. The latter has a non-hygrophanous, white pileus; smaller cheilocystidia (16–47 × 13–24 µm) with sparser surface protuberances; and with a minute snow white ring or ruff on the stipe base.

Collybiopsis dentata formed a stable branch on its own. It differs from *C. fucata* by its white, non-hygrophanous pileus, free lamellae, and serrated lamellar edges. And distinguished from *C. latispora* by the absence of a minute snow white ring or ruff on the stipe base, larger cheilocystidia (30–71 × 17–29 µm), and denser surface protuberances.

The major species of wood-inhabiting fungi are in Polyporales and Hymenochaetales, and extensive and systematic studies on these two orders have been carried out in China (Dai 2010; Cui et al. 2019; Dai et al. 2021; Wu et al. 2022a, 2022b; Wang et al. 2024; Liu et al. 2025b, 2025c). However, a few reports on wood-inhabiting fungi in Agaricales were published (Zhang et al. 2023a; Liu et al. 2024; Liu et al. 2025a), so the species diversity of wood-inhabiting Agaricales is still poorly known. Our present study expands our understanding of *Collybiopsis* species by providing descriptions and phylogenetic analyses for the four new species. These findings enrich our knowledge of the diversity of *Collybiopsis* in China. As more investigations on wood-inhabiting Agaricales are carried out, more species of *Collybiopsis* will be found.

Key to morphologically similar species

1 Pileipellis composed of cylindrical, often sub-inflated hyphae, not a rameales-type structure **2**
– Pileipellis composed of a coarse rameales-type structure hyphae **7**
2 Pleurocystidia present ..... ***G. lodgeae***
– Pleurocystidia absent **3**
3 Pileus hyphae encrusted with brownish granules ..... ***G. coracicolor***
– Pileus hyphae not encrusted with brownish granules **4**
4 Cheilocystidia absent ..... ***C. polygramma***
– Cheilocystidia present **5**
5 Pileus 32–61 mm in diameter ..... ***C. subpolygramma***
– Pileus < 25 mm in diameter **6**
6 Cheilocystidia narrowly clavate to clavate or broadly clavate to narrowly sphaero-pedunculate, some subfusoid to fusoid; apex obtuse, mucronate, diverticulate, or knobbed ..... ***G. hondurensis***
– Cheilocystidia filamentous, irregular, sometimes thickened or bulbous at the base, or thickened at the apex, and often constricted in multiple places ..... ***C. neotropica***
7 Basidiospores > 4.0 µm wide **8**
– Basidiospores < 4.0 µm wide **10**
8 Pileus hygrophanous, reddish-brown ..... ***C. fucata***
– Pileus not hygrophanous, white **9**
9 Pleurocystidia subcylindrical, narrow fusiform, narrow utriform, the branches of the cheilocystidia 2.7–11 × 1.2–3.1 µm, basidiospores 6.7–8.1 × 4.3–5.9 µm, ellipsoid to elongated-ellipsoid, and with a minute snow white ring or ruff on the stipe base ..... ***C. latispora***
– Pleurocystidia fusiform, utriform, the branches of the cheilocystidia 3.2–7.6 × 0.6–1.7 µm, basidiospores 6.7–8.2 × 3.9–4.7 µm, elongated-ellipsoid to cylindrical, no minute snow white ring or ruff on stipe base ..... ***C. dentata***
10 Minute snow white ring or ruff on stipe base ..... ***C. furtiva***
– No minute snow white ring or ruff on stipe base **11**
11 Lamellae with flocculose, stipe fauve to brownish ..... ***C. humillima***
– Lamellae not with flocculose, stipe not fauve to brownish **12**
12 Pleurocystidia absent **13**
– Pleurocystidia present **14**
13 Lamellae buff to pale pinkish buff, appearing whitish-crystalline when dried; stipe apex buff, central portion rusty red, base reddish-brown ..... ***C. californica***
– Lamellae white, often with rusty tawny to dark brick-colored spots; stipe greyish yellow to buff-brown; overall stipe turns rusty tawny to brick upon drying ..... ***C. foliiphila***
14 Lamellae subdistant to close (40–43), subdecurrent, adnexed to adnate to appearing free, basidiospores slender ellipsoid, pleurocystidia digitate to narrowly fusiform ..... ***C. ramealis***
– Lamellae few (12–13), adnexed to subdecurrent, basidiospores cylindrical to elongate-ellipsoid, pleurocystidia stalked-fusiform, rounded apically ..... ***C. filamentipes***

Acknowledgments

The authors are very grateful for the assistance of Bin-Rong Ke, Zhi-Heng Zeng, Qin Na, Yu-Peng Gai, and Ya-Ping Hu in the field specimen collection and the anonymous reviewers of the manuscript.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

This work was financed by the National Natural Science Foundation of China (32460326), the Jiangxi Provincial Natural Science Foundation (20224BAB205003), the Project of FAAS (XTCXGC2021007), and Census and Collection of Edible Mushroom Germplasm Resources in Fujian Province (fjmacro-001).

Author contributions

Conceptualization, Jun-Qing Yan; methodology, Jun-Qing Yan and Sheng-Nan Wang; software, Ling Ding and Ben-Jian Zhong; formal analysis, Hui Zeng, Jun-Qing Yan, and Sheng-Nan Wang; investigation, Ling Ding, Ben-Jian Zhong, and Jun-Qing Yan; resources, Hui Zeng and Jun-Qing Yan; writing—original draft, Ling Ding; writing—review and editing, Jun-Qing Yan; visualization, Jun-Qing Yan and Sheng-Nan Wang; supervision, Jun-Qing Yan; project administration, Jun-Qing Yan; funding acquisition, Jun-Qing Yan. All authors have read and agreed to the published version of the manuscript.

Author ORCIDs

Ling Ding https://orcid.org/0009-0000-5293-046X
Ben-Jian Zhong https://orcid.org/0009-0004-0817-9161
Hui Zeng https://orcid.org/0000-0003-2025-844X
Sheng-Nan Wang https://orcid.org/0000-0003-0648-271X
Jun-Qing Yan https://orcid.org/0000-0003-1128-5171

Data availability

All of the data that support the findings of this study are available in the main text.

References

Antonín V, Hosaka K, Kolařík M (2022) Taxonomy and phylogeny of *Paramarasmius* gen. nov. and *Paramarasmius mesosporus*, a worldwide distributed fungus with a strict ecological niche. Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology 157: 1–12. https://doi.org/10.1080/11263504.2022.2100503

Bas C (1969) Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia-Molecular Phylogeny and Evolution of Fungi 5: 285–573.

Bau T, Yan JQ (2021) A new genus and four new species in the /*Psathyrella* s.l. clade from China. MycoKeys 80: 115–131. https://doi.org/10.3897/mycokeys.80.65123

César E, Montoya L, Bandala VM, Ramos A (2020) Three new marasmioid-gymnopoid rhizomorph-forming species from Mexican mountain cloud forest relicts. Mycological Progress 19: 1017–1029. https://doi.org/10.1007/s11557-020-01608-1

Chen LG, Ding L, Chen H, Zeng H, Zeng ZH, Wang SN, Yan JQ (2024) Seven New Species of *Entoloma* Subgenus *Cubospora* (Entolomataceae, Agaricales) from Subtropical Regions of China. Journal of Fungi (Basel, Switzerland) 10: 594. https://doi.org/10.3390/jof10080594

Cho M, Kwon SL, Kim C, Kim JJ (2024) Notes of Five Wood-Decaying Fungi from Juwangsan National Park in Korea. Mycobiology 52: 30–41. https://doi.org/10.1080/12298093.2023.2299098

Cui BK, Li HJ, Ji X, Zhou JL, Song J, Si J, Yang ZL, Dai YC (2019) Species diversity, taxonomy and phylogeny of Polyporaceae (Basidiomycota) in China. Fungal Diversity 97: 137–392. https://doi.org/10.1007/s13225-019-00427-4

Dai YC (2010) Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity 45: 131–343. https://doi.org/10.1007/s13225-010-0066-9

Dai YC, Yang ZL, Cui BK, Wu G, Yuan HS, Zhou LW, He SH, Ge ZW, Wu F, Wei YL, Yuan Y, Si J (2021) Diversity and systematics of the important macrofungi in Chinese forests. Mycosystema 40: 770–805. https://doi.org/10.13346/j.mycosystema.210036

Deng SF, Li TH, Jiang ZD, Song B (2016) *Gymnopus ramulicola* sp. Nov., a pinkish species from southern China. Mycotaxon 131: 663–670. https://doi.org/10.5248/131.663

Dennis RWG (1951) Some Agaricaceae of Trinidad and Venezuela. Leucosporae 34(Part I): 411–482. https://doi.org/10.1016/S0007-1536(51)80030-5

Desjardin DE (1987) New and Noteworthy Marasmioid Fungi from California. Mycologia 79: 123–134. https://doi.org/10.1080/00275514.1987.12025378

Desjardin DE, Perry BA (2017) The gymnopoid fungi (Basidiomycota, Agaricales) from the Republic of São Tomé and Príncipe, West Africa. Mycosphere 8: 1317–1391. https://doi.org/10.5943/mycosphere/8/9/5

Dutta AK, Wilson AW, Antonín V, Acharya K (2015) Taxonomic and phylogenetic study on gymnopoid fungi from Eastern India. I. Mycological Progress 14: 1–18. https://doi.org/10.1007/s11557-015-1094-3

Gardes M, Bruns TD (1993) ITS primers with enhanced specificity for basidiomycetes-application to the identification of mycorrhizae and rusts. Molecular Ecology 2: 113–118. https://doi.org/10.1111/j.1365-294X.1993.tb00005.x

Horak E (2005) Röhrlinge und Blätterpilze in Europa: Bestimmungsschlüssel für Polyporales (pp), Boletales, Agaricales, Russulales. Elsevier, Spektrum, Akad. Verl., Munich, Germany, 557 pp.

Hughes KW, Petersen RH (2015) Transatlantic disjunction in fleshy fungi III: *Gymnopus confluens*. MycoKeys 9: 37–63. https://doi.org/10.3897/mycokeys.9.4700

Kalyaanamoorthy S, Minh BQ, Wong TKF, Haeseler AV, Jermiin LS (2017) ModelFinder: Fast model selection for accurate phylogenetic estimates. Nature Methods 14: 587–589. https://doi.org/10.1038/nmeth.4285

Katoh K, Rozewicki J, Yamada KD (2019) MAFFT online service: Multiple sequence alignment, interactive sequence choice and visualization. Briefings in Bioinformatics 20: 1160–1166. https://doi.org/10.1093/bib/bbx108

Kim JS, Cho Y, Park KH, Park JH, Kim M, Kim CS, Lim YW (2022) Taxonomic study of *Collybiopsis* (Omphalotaceae, Agaricales) in the Republic of Korea with seven new species. MycoKeys 88: 79–108. https://doi.org/10.3897/mycokeys.88.79266

Kornerup A, Wanscher JH (1978) Methuen Handbook of Colour. Eyre Methuen Ltd., London, UK, 252 pp.

Li JP, Oliveira JJS, Pan MC, Deng CY, Antonín V, Xiao ZD, Li FF, Li TH, Li Y, Dai YT, Li CT (2024) Notes on all Genera of Omphalotaceae: Expanding the Taxonomic Spectrum in China and Revisiting Historical Type Specimens. Mycosphere 15: 1522–1594. https://doi.org/10.5943/mycosphere/15/1/13

Liu XC, Lin ZJ, Liang YS, Cao LX, Qiu LH (2024) *Collybiopsis baiyunensis* sp. nov. (Omphalotaceae, Agaricales) from Baiyun Mountain, Southern China. Phytotaxa 640: 183–195. https://doi.org/10.11646/phytotaxa.640.2.7

Liu S, Pan M, Cui BK, Zhu B (2025a) Catalogue of fungi in China 5. Preliminary survey of macrofungi in Medog, Southwest China. Mycology, 1–48. https://doi.org/10.1080/21501203.2025.2471382

Liu ZB, Liu HG, Vlasák J, Gates GM, Dai YC, Yuan Y (2025b) Global diversity and phylogeny of Incrustoporiaceae (Polyporales, Basidiomycota) with an emphasis on Skeletocutis. Mycology: 1–58. https://doi.org/10.1080/21501203.2024.2448145

Liu ZB, Yuan Y, Dai YC, Liu HG, Vlasák J, Zeng GY, He SH, Wu F (2025c) Global diversity and systematics of Hymenochaetaceae with non-poroid hymenophore. Fungal Diversity 131: 1–97. https://doi.org/10.1007/s13225-025-00552-3

López-Ferrer GJ (2004) *Collybia* sensu lato of the central and western regions of Puerto Rico: biotechnological capabilities, characterization and identification using traditional and molecular techniques. University of Puerto Rico, Mayaguez (Puerto Rico).

Mata JL, Ovrebo CL (2009) New reports and illustrations of *Gymnopus* for Costa Rica and Panama. Fungal Diversity 38: 125–131.

Mata JL, Petersen RH (2003) Type studies of neotropical *Collybia* species. Mycotaxon 38: 303–316.

Mata JL, Hughes KW, Petersen RH (2004) Phylogenetic placement of *Marasmiellus juniperinus*. Mycoscience 45: 214–221. https://doi.org/10.1007/s10267-004-0170-3

Mata JL, Hughes KW, Petersen RH (2007) An investigation of /omphalotaceae (Fungi: Euagarics) with emphasis on the genus *Gymnopus*. Sydowia 58: 191–289.

Nguyen LT, Schmidt HA, Haeseler AV, Minh BQ (2015) IQ-TREE: A Fast and Effective Stochastic Algorithm for Estimating Maximum-Likelihood Phylogenies. Molecular Biology and Evolution 32: 268–274. https://doi.org/10.1093/molbev/msu300

Noordeloos ME (1983) Notulae as Floram agaricinam neerlandicam—I–III. *Marasmiellus*, *Macrocystidia* and *Rhodocybe*. Persoonia-Molecular Phylogeny and Evolution of Fungi 12: 31–49.

Oliveira JJS, Vargas-Isla R, Cabral TS, Rodrigues DP, Ishikawa NK (2019) Progress on the phylogeny of the Omphalotaceae: *Gymnopus* s. str., *Marasmiellus* s. str., *Paragymnopus* gen. nov. and *Pusillomyces* gen. nov. Mycological Progress 18: 713–739. https://doi.org/10.1007/s11557-019-01483-5

Petersen RH, Hughes KW (2014) New North American species of *Gymnopus*. North American Fungi 9: 1–22. https://doi.org/10.2509/naf2014.009.003

Petersen RH, Hughes KW (2016) *Micromphale* sect. *Perforantia* (Agaricales, Basidiomycetes); Expansion and phylogenetic placement. MycoKeys 18: 1–122. https://doi.org/10.3897/mycokeys.18.10007

Petersen RH, Hughes KW (2021) *Collybiopsis* and its type species, *Co. ramealis*. Mycotaxon 136: 263–349. https://doi.org/10.5248/136.263

Petersen RH, Hughes KW (2024) Two new species of *Collybiopsis* (Agaricales, Omphalotaceae) from Eastern North America. MycoKeys 107: 95–124. https://doi.org/10.3897/mycokeys.107.122634

Petersen RH, Hughes KW, Voitk A (2014) *Gymnopus eneficola*-species nova from Newfoundland. Ecology and Evolutionary Biology 5: 5–12.

Razzaq F, Khalid AN, Ashraf S (2023) *Collybiopsis pakistanica* (Omphalotaceae, Agaricales, Basidiomycota), a new mushroom species from Margalla Hills, Pakistan and two new combinations. Nordic Journal of Botany 4: e03849. https://doi.org/10.1111/njb.03849

Schoch CL, Robbertse B, Robert V, Vu D, Cardinali G, Irinyi L, Meyer W, Nilsson RH, Hughes K, Miller AN, Kirk PM, Abarenkov K, Aime MC, Ariyawansa HA, Bidartondo M, Boekhout T, Buyck B, Cai Q, Chen J, Crespo A, Crous PW, Damm U, De Beer ZW, Dentinger BT, Divakar PK, Duenas M, Feau N, Fliegerova K, Garcia MA, Ge ZW, Griffith GW, Groenewald JZ, Groenewald M, Grube M, Gryzenhout M, Gueidan C, Guo L, Hambleton S, Hamelin R, Hansen K, Hofstetter V, Hong SB, Houbraken J, Hyde KD, Inderbitzin P, Johnston PR, Karunarathna SC, Koljalg U, Kovacs GM, Kraichak E, Krizsan K, Kurtzman CP, Larsson KH, Leavitt S, Letcher PM, Liimatainen K, Liu JK, Lodge DJ, Luangsa-ard JJ, Lumbsch HT, Maharachchikumbura SS, Manamgoda D, Martin MP, Minnis AM, Moncalvo JM, Mule G, Nakasone KK, Niskanen T, Olariaga I, Papp T, Petkovits T, Pino-Bodas R, Powell MJ, Raja HA, Redecker D, Sarmiento-Ramirez JM, Seifert KA, Shrestha B, Stenroos S, Stielow B, Suh SO, Tanaka K, Tedersoo L, Telleria MT, Udayanga D, Untereiner WA, Dieguez Uribeondo J, Subbarao KV, Vagvolgyi C, Visagie C, Voigt K, Walker DM, Weir BS, Weiss M, Wijayawardene NN, Wingfield MJ, Xu JP, Yang ZL, Zhang N, Zhuang WY, Federhen S (2014) Finding needles in haystacks: Linking scientific names, reference specimens and molecular data for Fungi. Database (Oxford) 2014. https://doi.org/10.1093/database/bau061

Sesli E, Antonín V, Hughes KW (2018) *Marasmiellus istanbulensis* (Omphalotaceae), a new species from Belgrade Forest (İstanbul-Turkey). Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology 152: 666–673. https://doi.org/10.1080/11263504.2017.1317670

Singer R (1961) Diagnoses Fangorum novorum Agaricalium II. Sydowia 15: 45–83.

Vilgalys R, Hester M (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several Cryptococcus species. Journal of Bacteriology 172: 4238–4246. https://doi.org/10.1128/jb.172.8.4238-4246.1990

Vu D, Groenewald M, de Vries M, Gehrmann T, Stielow B, Eberhardt U, Al-Hatmi A, Groenewald JZ, Cardinali G, Houbraken J, Boekhout T, Crous PW, Robert V, Verkley GJM (2019) Large-scale generation and analysis of filamentous fungal DNA barcodes boosts coverage for kingdom fungi and reveals thresholds for fungal species and higher taxon delimitation. Studies in Mycology 92: 135–154. https://doi.org/10.1016/j.simyco.2018.05.001

Wang CG, Dai YC, Kout J, Gates GM, Liu HG, Yuan Y, Vlasák J (2024) Multi-gene phylogeny and taxonomy of *Physisporinus* (Polyporales, Basidiomycota). Mycosphere 15: 1455–1521. https://doi.org/10.1080/21501203.2024.2379476

Wei YL, Dai YC (2004) Ecological function of wood-inhabiting fungi in forest ecosystem. Chinese Journal of Applied Ecology, 1935–1938.

White TJ, Bruns T, Lee S, Taylor J (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (Eds) PCR Protocols: A Guide to Methods and Applications. Academic Press, New York: 315–322. https://doi.org/10.1016/B978-0-12-372180-8.50042-1

Wu F, Man XW, Tohtirjap A, Dai YC (2022a) A comparison of polypore funga and species composition in forest ecosystems of China, North America, and Europe. Forest Ecosystems 9: 100051. https://doi.org/10.1016/j.fecs.2022.100051

Wu F, Zhou LW, Vlasák J, Dai YC (2022b) Global diversity and systematics of Hymenochaetaceae with poroid hymenophore. Fungal Diversity 113: 1–192. https://doi.org/10.1007/s13225-021-00496-4

Zhang QY, Liu HG, Papp V, Zhou M, Dai YC, Yuan Y (2023a) New insights into the classification and evolution of *Favolaschia* (Agaricales, Basidiomycota) and its potential distribution, with descriptions of eight new species. Mycosphere 14: 777–814. https://doi.org/10.5943/mycosphere/14/1/10

Zhang QY, Zhou M, Shi FM, Si J, Li HJ (2023b) *Collybiopsis bambusicola* sp. nov. in Yunnan Province, Southwestern China. Phytotaxa 578: 125–135. https://doi.org/10.11646/phytotaxa.578.1.7